Figure 2. Natural Hazards Sequence Tree

Figure 3. Schematic of a landfill showing potential deformation of leachate collection pipes by seismic stress (landfill geometric details are not provided. (Inyang, 1992)

Figure 4. An illustration of external monitoring systems using point, linear and areal sensors, that could be configured to detect damages in sensitive environments (adapted from Inyang et al, 1996).

Table 2. Examples of traditional and innovative monitoring techniques for specific waste containment problems, for possible use in high hazard situations. (Inyang, 1994b)

REFERENCES

- **Forrest, B.** and **Nishenko, S.** 1996. Losses due to natural hazards. *Natural Hazards Observer,* Sept., pp. 16-17.
- Inyang, H. I., Betsill, J.D., Breeden, R., Chamberlain, G.H., Dutta, S., Everett, L., Fuentes, R., Hendrickson J., Koutsandreas, J., Lesmes, D., Loomis, G., Mangion, S.M., Morgan, D., Pfeifer, C., Puls, R.W., Stamnes, R.L., Vandel, T.D. and Williams, C. 1996. Performance monitoring and evaluation. Chapter 12 of *Assessment of Barrier Containment Technologies*, editors: Rumer, R.R., and Mitchell, J.K., Text prepared under the auspices of U.S. Dept. of Energy, U.S. Environmental Protection Agency, and DuPont Company, pp. 355-400.
- **Inyang, H.I.** 1994a. Mitigation of flood hazards to waste treatment, storage and disposal facilities in flood-prone areas. *Technical Guidance and Resource Document,* Office of Solid Waste, U.S. Environmental Protection Agency, Washington, DC, 94 pages.
- Inyang, H.I. 1994b. Cost-effective post construction integrity verification monitoring and testing techniques for subsurface barrier containment facilities. *Technical Analysis Document*, DuPont Chemicals, Wilmington, Delaware, 78 pages.
- **Inyang, H.I.** 1992. Aspects of landfill design for stability in seismic zones. *Journal of Environmental Systems,* Vol. 21, No. 3, pp. 223-235.
- **Inyang, H.I.** 1991. Hazardous Waste facilities in seismic zones. *AAAS/U.S.EPA Environmental Science and Engineering Fellowship Report.* American Association for the Advancement of Science, Washington, DC, 81 pages.
- **Keck, P.** 1996. Public/private partnerships play increasing role in disaster response. *Public Works*, December, pp. 24-25.
- NRC. 1989. Reducing disaster's toll: the United States Decade for Natural Disaster Reduction. Commission on Engineering and Technical Systems, National Research Council, Washington, DC, 39 pp.

- NSTC 1996. Natural disaster reduction: a plan for the nation. National Science and Technology Council, Committee on Environment and Natural Resources, Subcommittee on Natural Disaster Reduction, Washington, DC, 44 pp.
- **Parfit, M.** and **Richardson, J.** 1998. Living with natural hazards. *National Geographic*, Vol. 194, No. 1, July, pp. 2-38.
- **SAB** 1995. Future Issues in Environmental Engineering (EPA-SAB-EEC-95-004), Science Advisory Board, USEPA Washington DC
- SAB 1998. Review of the Office of Solid Waste's Proposed Surface Impoundment Study (EPA-SAB-EEC-98-009) Science Advisory Board, USEPA Washington DC
- SAB 1998 Consultation on Alternative Approaches for Disposal of Federal Low-Activity Radioactive Wastes (EPA-SAB-RAC-CON-98-001), Science Advisory Board, USEPA Washington DC
- **Showstack, R.** 1998. Planning cuts risk from many natural hazards, experts say, EOS Transactions, *American Geophysical Union*, Vol. 79, No. 17, April 28, pp. 205-206.
- Wright, F. G., Inyang, H.I. and Myers, V. B., 1993. Risk reduction through regulatory control of waste disposal facility siting. *Journal of Environmental Systems*, Vol. 22, No. 2, pp. 27-35.

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